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FAUNAL AFFINITIES OF SOME HAWAIIAN BRYOZOA (ECTOPROCTA)[1,2]

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The tropical mid-Pacific bryozoan (Phylum Ectoprocta) fauna and its affinities are largely unknown, owing not only to the limited studies that have been made in that region but also, until relatively recent years, to the scarcity of thorough eastern Pacific studies which might be used for comparative purposes.

In the Hawaiian region, the only bryozoan studies were those of Busk (1884), and Canu and Bassler (1927). Busk reported on 14 species which had been collected by H.M.S. *Challenger* off Honolulu in July–August of 1875, from depths of 20 to 40 fathoms. Of the 14 species, Busk described 12 as new. Canu and Bassler reported on collections dredged by the U. S. Fish Commission Steamer *Albatross* in the Hawaiian Islands between 1891 and 1910. Much of their material came from depths of 100 to nearly 700 meters, and water temperatures were recorded as ranging from 25.8° C. down to 5° C. They described 25 new species from the 43 species collected.

The faunal affinities of the known species in the two collections were varied. Of Busk's two known species, one had been previously reported from both Indo-Pacific and Florida waters; the other had been described from New South Wales. Of Canu and Bassler's 18 known species, 11 were called cosmopolitan, and 5 had been previously reported in the eastern Pacific. Only three of Busk's 14 species were collected again by the *Albatross*, but this is not surprising since the depths of collection differed considerably.

Recently the present authors were invited to examine and identify the bryozoan collections of the Bishop Museum and the University of Hawaii, Honolulu. With the availability of this material, it is of interest to examine the

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faunal affinities and distribution patterns of the bryozoans found there, and to compare them with similar information available for other groups.

Canu and Bassler's paper in 1927 brought the total number of bryozoans known for the Hawaiian area to less than 60 species. At that time the fauna of the American coasts of the Pacific was only slightly better known. In the northeastern Pacific, the records of the groups were those of Hincks (1884) who reported 95 species from the Queen Charlotte Islands, and of C. H., and E. O'Donoghue (1923, 1925, 1926) who listed some 200 species or varieties from the Vancouver Island—Puget Sound region. Robertson (1905, 1908, 1910) had reported 98 species from the United States west coast, and Busk (1855) had recorded 13 species from Mazatlan, Mexico. Canu and Bassler were then preparing a report on 56 species from the Galápagos Islands (1930), while Hastings had in preparation a paper on 62 species from the Panama area (1930). These were the references available to Canu and Bassler for comparing their Hawaiian species with those of the mainland.

While the bryozoan fauna in the eastern Pacific still cannot be said to be completely known, records published during the past 16 years offer much more comprehensive knowledge of the fauna and its distribution than was previously available for comparison with other regions. Osburn's monographs (1950, 1952, 1953) summarized all the known west coast records and reported on a great many additional species collected by the Allan Hancock Pacific Expeditions. In the tropical and subtropical latitudes alone, he reported on 133 species from the Gulf of California and 120 species from the west coast of Baja California.

Subsequently, Soule (1959, 1961, 1963) reported 160 Gulf of California species from the *Puritan*—American Museum Expedition, 59 of which had been previously unreported from that area. In Hertlein (1963), Soule also listed 20 species found at Cocos Island. The Soules (1964) reported 37 species from Scammon's Lagoon on the Pacific Coast of Baja California, 17 of which were previously unreported on that coast.

Examination of the Bishop Museum collections has revealed a number of species which are common to both the Hawaiian Islands and eastern Pacific waters, either along the mainland coast of the Americas or in the offshore islands. While a complete report on some 30 species of the Bishop Museum collection is in preparation at present, notice can be taken here of the following 13 species which are common to both locations, and of their distribution elsewhere.

Bugula californica Robertson, 1905. This species ranges along the Pacific coast from British Columbia to Mexico, the Gulf of California, and the Galápagos Islands, in cool temperate to tropical waters. It has been reported also in Brazil (Osburn, 1950; Soule, 1959). Common as a fouling organism on dock pilings and boat hulls, it could presumably be spread by boats or floating logs. Not previously reported from the Hawaiian Islands.

Bugula neritina (Linnaeus), 1758. This species is distributed around the world in warm temperate to tropical shallow waters. Along the Pacific coast it is found southward from Monterey Bay, California, to the Panama Canal Zone and the Galápagos Islands, as well as in the southern part of the Gulf of California (Osburn, 1950; Soule, 1959).

Colletosia radiata (Moll), 1803. The species is apparently cosmopolitan; it is known from British Columbia to Peru, in the Galápagos Islands, Cocos Island, the Gulf of California and Scammon's Lagoon, Baja California. It occurs in shallow water to 136 fathoms, incrusting on shells, worm tubes, rocks and on other bryozoans (Osburn, 1950; Soule, 1959).

Hippopodina feegeensis (Busk), 1884. A warm water form, the species is found in the western Pacific and Indian Ocean (Indo-Pacific) and from Florida to Brazil. It has been found only off Colombia and as a Pleistocene fossil in southern California in the eastern Pacific (Harmer, 1926; Osburn, 1952).

Hippothoa distans MacGillivray, 1869. There are numerous records of this species around the world; the north and south Atlantic, western Pacific, Mediterranean, and the Antarctic (Harmer, 1926). *Hippothoa distans* was found by Canu and Bassler (1927) in Hawaii, and it is known in the eastern Pacific off Mexico, Panama and Peru, in the Gulf of California, Scammon's Lagoon and the Galápagos Islands (Soule, 1961; Soule and Soule, 1964). Usually it is incrusted on shells.

Membranipora tuberculata (Bosc), 1802. This species is usually found on floating or attached algae; it is common on *Sargassum* in the Atlantic ranging from North Carolina to Brazil. In the eastern Pacific it is found on kelp off California, and on other algae, extends into the Gulf of California, Scammon's Lagoon and the Galápagos Islands and south to Peru (Osburn, 1950; Soule, 1959; Soule and Soule, 1964). Also known from the Indo-Pacific, no doubt *M. tuberculata* has spread by floating on algae over the world. The authors collected the only specimens known from Hawaii. It was found on *Sargassum* off the Kona coast of the Island of Hawaii, where unfortunately (?) a new hotel is now under construction on ground filled in the cove at the precise location; a small colony was also found at Napili Bay, Island of Maui.

Parellisina curvirostris (Hincks), 1862. Although this incrusting species is known around the world in warmer waters, it has been found in the eastern Pacific only in offshore waters at Clipperton, Cocos and the Galápagos Islands and in the Gulf of Panama (Osburn, 1950). Canu and Bassler (1927) reported it from Hawaii as *Callopora curvirostris* Hincks, 1861 (sic.).

Reteporellina denticulata (Busk), 1884. Originally described from shallow waters by Busk (*Retepora denticulata*), the species was subsequently found in a number of warm Indo-Pacific locations (Harmer, 1934). Osburn (1952) reported a variety, *gracilis*, from the Galápagos and Cocos Islands in water from 5 to 150 fathoms in depth, and Soule (1961) collected the variety in the

Gulf of California from 2–40 fathoms deep. It is an erect, branching species.

Rhynchozoon rostratum (Busk), 1855. Originally described from Mazatlan, Mexico, this species which incrusts rocks and shells is found from British Columbia (as *R. tumulosum*), to Panama and Colombia, and in the Galápagos Islands. In the Atlantic it extends from New England to Brazil and into the Caribbean. This is the first report of the species outside of the American continents, although a similar species is known in the Mediterranean and Indian Ocean (Osburn, 1952; Soule, 1961; Soule and Soule, 1964).

Savignyella lafonti (Audouin), 1826. This species is known around the world in warmer waters, but it is not common on the Pacific coast. There it has been reported only in southern California harbors, off Panama and Colombia, and in the Galápagos Islands; it is apparently common in the Caribbean (Osburn, 1952). The colony is bright red and erect.

Schizoporella unicornis (Johnston), 1847. An incrusting species, it is found on rocks, wood and shells, particularly oysters. It is common in the north Atlantic and south to Brazil along the American coasts, as well as in the Pacific and Indian Oceans. It was apparently introduced into California waters, the Gulf of California and Scammon's Lagoon on imported oysters (Osburn, 1952; Soule, 1961; Soule and Soule, 1964). It is now common in the Hawaiian Islands in shallow water.

Trypostega venusta (Norman), 1864. This is a widely distributed incrusting species found in tropical and temperate seas of the Indian, Pacific and Atlantic Oceans (Harmer, 1926). In the eastern Pacific it has been reported from southern California to Ecuador, the Gulf of California and at Socorro, Clarion, Cocos, and the Galápagos islands (Osburn, 1952; Soule, 1961).

Zoobotryoon verticillatum (del Chiaje), 1828. The species is a common fouling organism occurring in tropical waters around the world (Osburn, 1953). Found in the Gulf of California, it occasionally extends into southern California waters during periods of higher water temperatures.

Discussion

In traditional zoogeographic studies the tropical central Pacific islands have often been considered to lie in the easternmost extension of the Indo-Pacific faunal province. The eastern Pacific Ocean and offshore islands in the tropical latitudes have been included in the Panamic province, and that fauna considered to be more closely allied to the Caribbean-Atlantic fauna. Thus the eastern Pacific Ocean was believed to act as a barrier of such depth and width that faunal transport across it would rarely occur. (Ekman, 1935, 1953; Sverdrup, 1942). Such zoogeographical conclusions no doubt reflected the lack of distribution data available, rather than a true lack of animals, since studies of many major groups in the eastern Pacific lagged far behind those of European, Atlantic and Indo-Pacific waters.

Garth (1946, 1965) in discussing the distribution of brachyuran Crustacea, noted the occurrence of Indo-west Pacific species in the Galápagos Islands as well as at Clarion, Socorro, Cocos, and Clipperton islands. Recently Garth (1967) has stated that, with faunal investigations in those islands reasonably complete, it can be seen that the occurrence of Indo-west Pacific species in those island areas is not an isolated phenomenon, but one that occurs regularly and predictably in all groups having larvae suited to transport by ocean currents. Indo-west Pacific Brachyura are apparently not transported from offshore islands to the mainland, as is the case in some groups.

Hertlein (1937) discussed the existence of an Indo-Pacific element in the molluscan fauna of the western Americas which had presumably been transported across the Pacific by water currents. He noted 27 shallow water species identical, or close to species of Polynesian waters. About half of these are found only on the offshore islands; the others occur also in mainland coastal waters.

Garth (1965) and Hertlein and Emerson (1957) considered Clipperton Island as the easternmost extension of the Indo-Pacific faunal province. In reporting on the Mollusca of Clipperton, the latter authors pointed out that approximately 60 percent of the gastropods found there were Indo-Pacific or had close affinities. Ten of the 14 Indo-Pacific species were those found also in the Hawaiian Islands, the northeastern limit of the Indo-Pacific province. About 30 percent of the Clipperton mollusks were also known in mainland waters.

Hertlein (1963), in examining the biogeography of Cocos Island, listed the mollusks and their distribution patterns, as well as giving species lists of several other phyla reported from Cocos Island by various authorities. The majority of species in all the groups reported, including the bryozoans listed by Soule, were Panamic species; a small proportion were Indo-Pacific, and only a very few were Caribbean-Atlantic species.

The situation with the Echinodermata reported by Hertlein (1963) for Cocos Island is of interest in that none of the Asteroidea found were Indo-Pacific, one ophiuroid was Indo-Pacific, and one echinoid was known in Hawaii. Of the holothuroids, however, all were known in eastern Pacific coastal waters and 70 percent were also known to occur in Indo-Pacific waters. Many are virtually circumtropical.

The bryozoan species found to be common to both Hawaiian and eastern Pacific waters are cosmopolitan species or those having a worldwide distribution except perhaps for the coldest waters; *Rhynchozoon rostratum* is possibly the exception, since its synonymy is doubtful.

The transport of bryozoans over wide areas of the world seems to be a fairly common phenomenon, but one which is not as yet understood. Relatively few of the 4000 or more living species seem to be "hitchickers" such as those which incrust boat hulls and could thus be carried over long distances. By far the

majority of the adult colonies are incrusted on rock, dead coral or mollusk shells, which offer little or no opportunity for passive transport.

Bryozoans are pelagic in the larval stage, and as such, could be transported by currents. The chief difficulty with this supposition is that the larvae of most of the species have never been identified in the plankton, and there is little data on the length of the pelagic period. Such data as appears in the literature would tend to indicate that the pelagic stage lasts only a few hours to a few days at most, which would provide insufficient time to cross a large expanse of water (Lynch, 1947; Mawatari, 1951; Ryland, 1960, 1962). The entire subject of transport in the bryozoans, both as larvae and adults, is in great need of thorough investigation.

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